

## **Modelling a Mitre Block**

*Using the 'Skeletal' modelling technique*



This tutorial will show you how to create a simple assembly model with Autodesk Inventor, using the 'Skeletal' modelling technique. Using skeletal modelling, we will start with a master part file which contains a master sketch which defines all the major geometry needed for our assembly. We will then 'Derive' our master sketch out into our part files. We will then build the features in each part as usual. Finally we will bring all the parts back into our assembly model. Using this method there is no need to add assembly constraints to lock the position of the parts, all parts can be grounded using their origin coordinates. The master part will control the size and layout of the assembly.

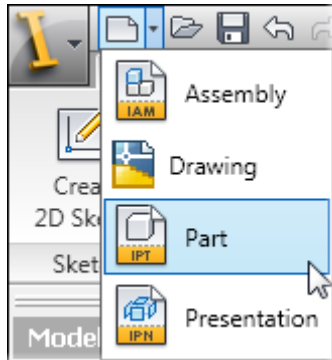
This article is aimed at novice users. However I am assuming that you are familiar with the concepts of parametric modelling, that you are comfortable creating and constraining sketches, and that you've had some time to explore the Inventor user interface.

In this tutorial we will use the following workflow:

- Create a part file
- Add parameters
- Create a sketch
- Constrain the sketch
- Create a new part file
- Derive the master sketch into the current part
- Add a sketch based feature (an extrusion)
- Change the look of a part
- Create the next part
- Add all the parts to the assembly
- 'Ground a root' the parts into position

**Creating the Master part**

Open a new part file.



Save your new part as 'Mitre Block Master Part' and create the following parameters.

**Add Parameters**

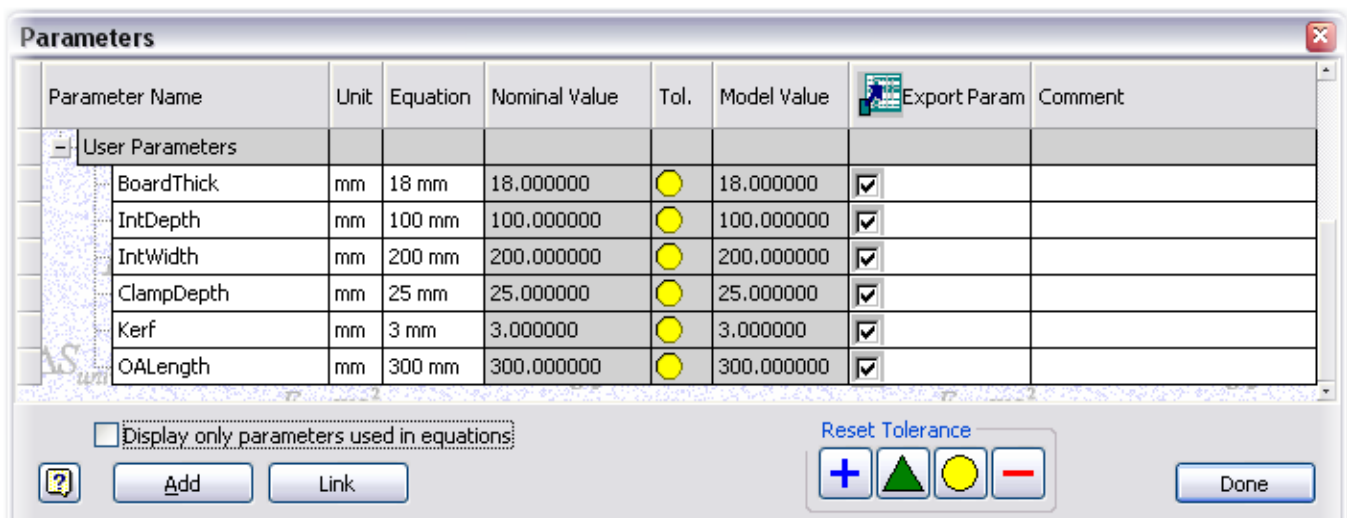
Manage Tab> Parameters Panel> Parameters tool



Name	Value
BoardThick	18
IntDepth	100
IntWidth	200
ClampDepth	25
Kerf	3
OALength	300

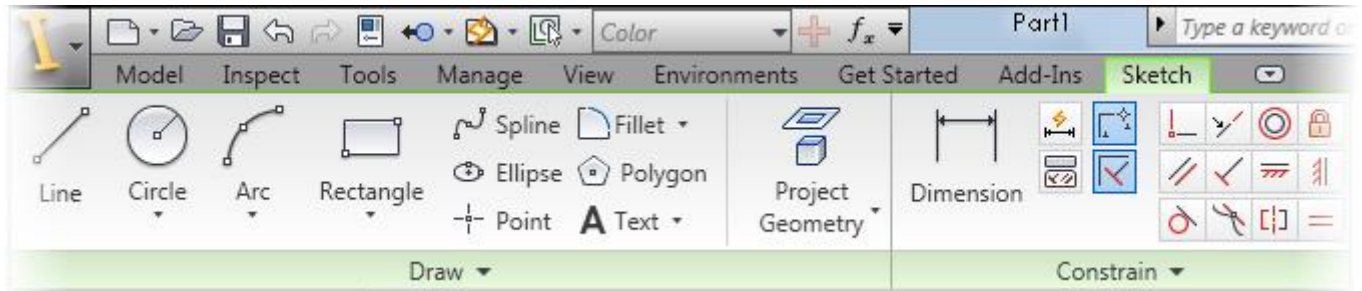
Use the 'Add' Button or ALT+A to add parameters.

*Don't forget that your parameter names cannot contain spaces, mathematical symbols, or special characters. Parameter names must start with a Letter and they are case sensitive*



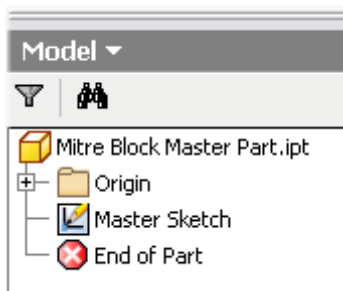
**Modelling a Mitre Block****Create a Master Sketch (or sketches...)**

You may notice that if you are in the sketch environment, the sketch tab in the ribbon is tinted green. Should you need to switch to a different tab this will help to guide you back to the currently active tab.



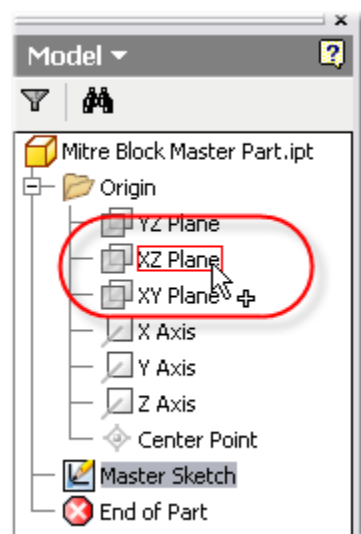
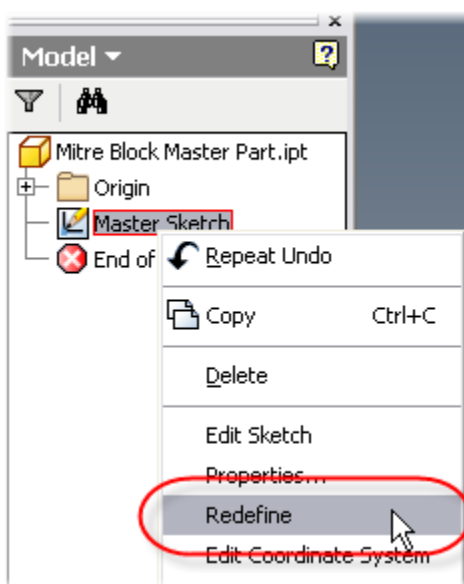
Click the 'Done' button when you have finished adding parameters and, if you need to, click on the big green tick to come out of the sketch environment and return to the part environment.

Click on the default sketch once to select it, and click again to rename it. Call it 'Master Sketch'



Right click on the Master sketch and choose 'Redefine'

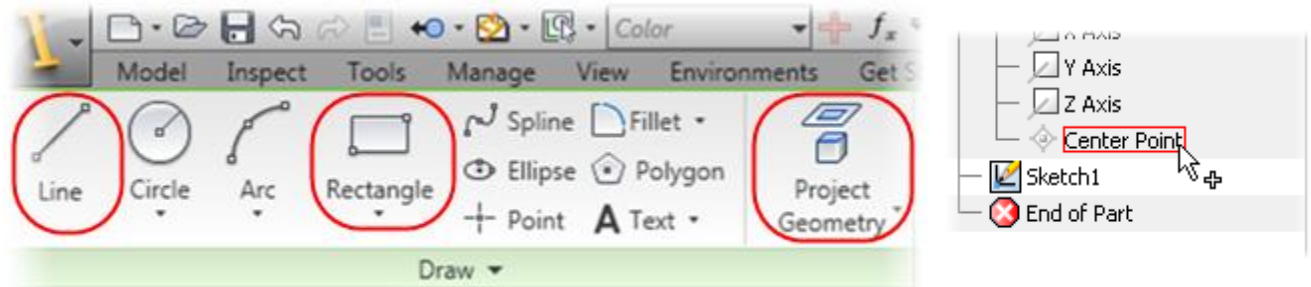
Select the XZ Plane for our first sketch



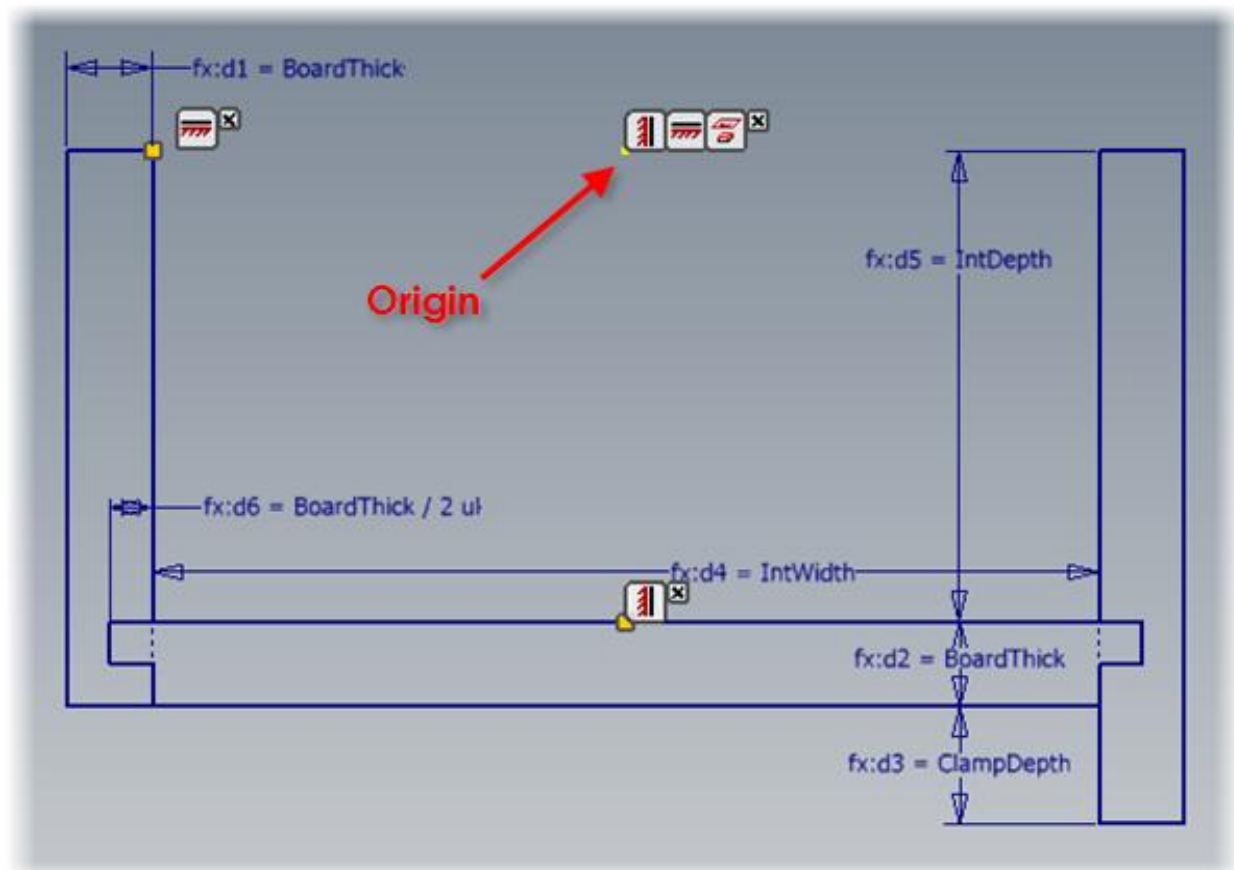
## Modelling a Mitre Block

Sketch out the height section through the Mitre block

Sketch Tab>Draw Panel

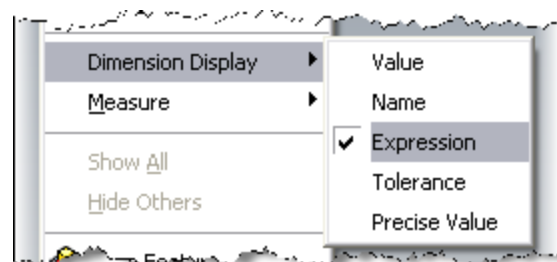


If you need to, use the 'Project Geometry' tool to project the origin centre point into the current sketch.



Sketch Tab > Draw Panel > Project geometry Tool

*If Your Dimension parameters don't show the Parameter Expression, as shown in the illustration, make sure that you don't have anything selected and right click anywhere in the drawing area to bring up the Dimension display options.*



## Modelling a Mitre Block

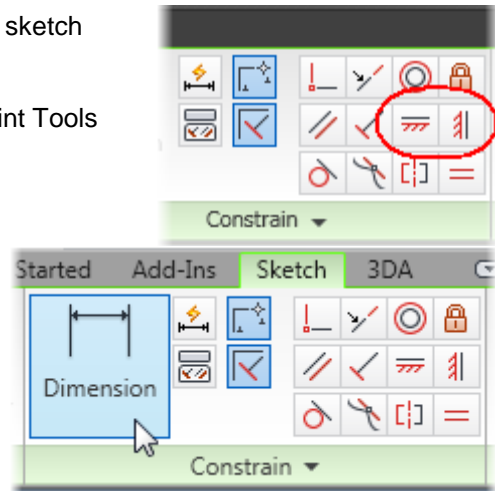
Use the Horizontal and Vertical constraint tools to centre your sketch about the origin.

Sketch Tab>Constrain Panel>Vertical and Horizontal Constraint Tools

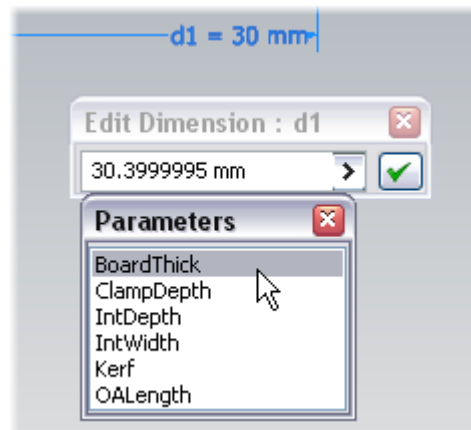
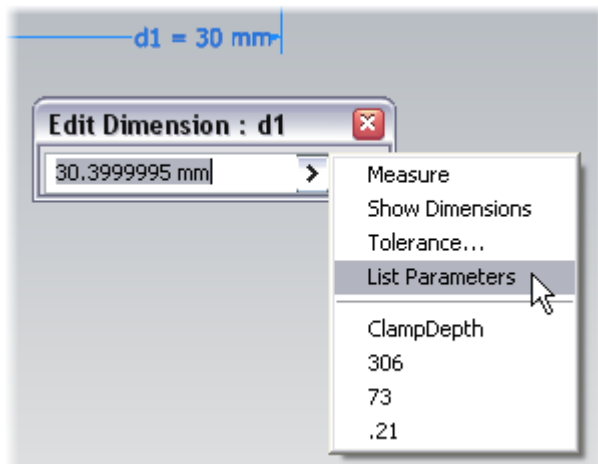
Add dimensional constraints to your sketch

Sketch Tab >Constrain Panel >Dimension Tool

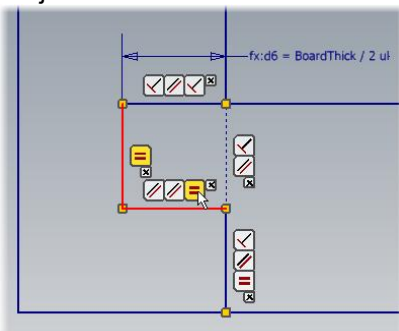
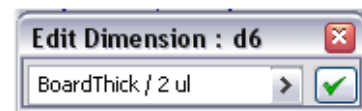
Single click on a dimension constraint to edit its value whilst using the dimension tool, or double click on a dimension constraint to edit its value at any other time. Click on the arrow at the end of the edit box and choose 'List parameters' to choose from the list of parameters that you created in the previous step.



You can also just type the name of your parameter into the edit box directly, but make sure that you spell the parameter name correctly and observe Lowercase/Uppercase Letters. Click on the green tick at the end of the edit box when you're done.



Note that we will set the Groove/Tongue dimension using an equation. We want the tongue and the groove to be half the thickness of the board, so we use the equation 'Board Thick divided by two'. This is written in the parameters box as 'BoardThick/2 ul'. 'ul' just means the two is unitless.



Use an 'Equal' constraint to make the tongue and groove the same size.

When your sketch is fully constrained, Click on the big green tick on the 'Exit' panel of the 'Sketch' Tab to complete the sketch and return to the part modelling environment.



## Modelling a Mitre Block

It can help to keep your screen less cluttered if you turn the display of sketch dimensions off. You can do this whilst in the Part environment, by right clicking on any sketch and choosing 'Dimension Visibility'. This setting is per sketch.

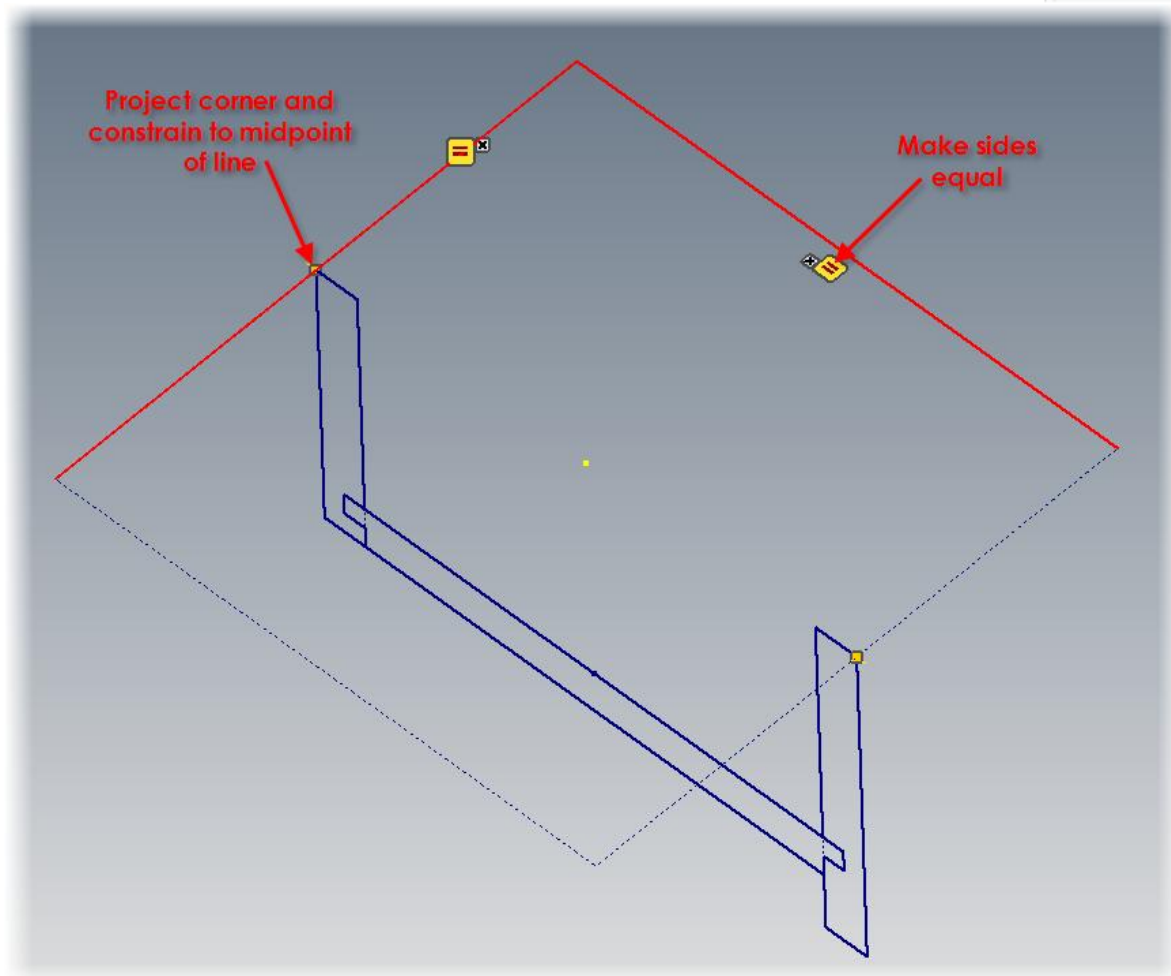
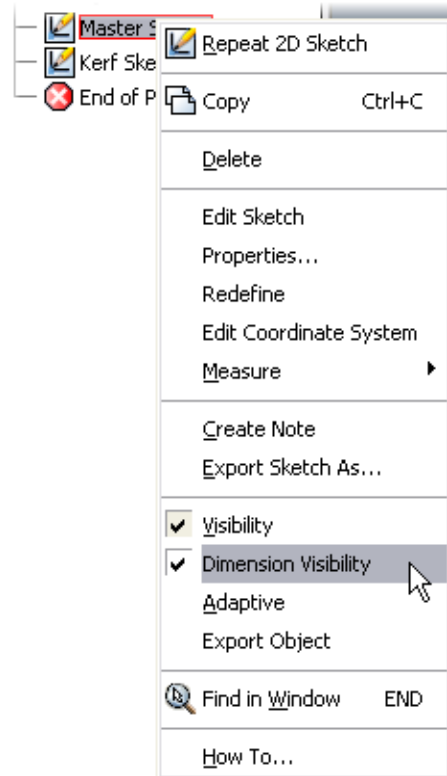
### Creating the Kerf Sketch

Next create a second sketch, this time choosing the 'XY' plane as a base plane. Name this sketch 'Kerf Sketch'.

Use the 'Construction' toggle to switch to construction geometry and sketch out a square.



Sketch Tab> Format Panel > Construction

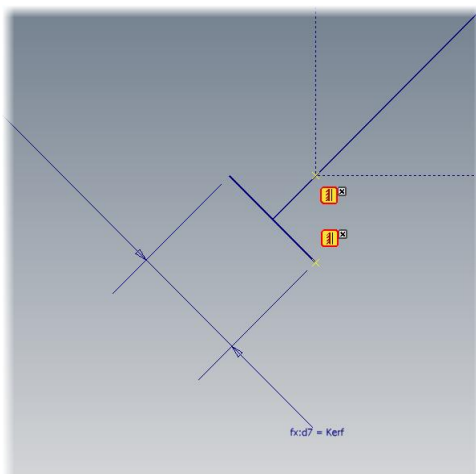
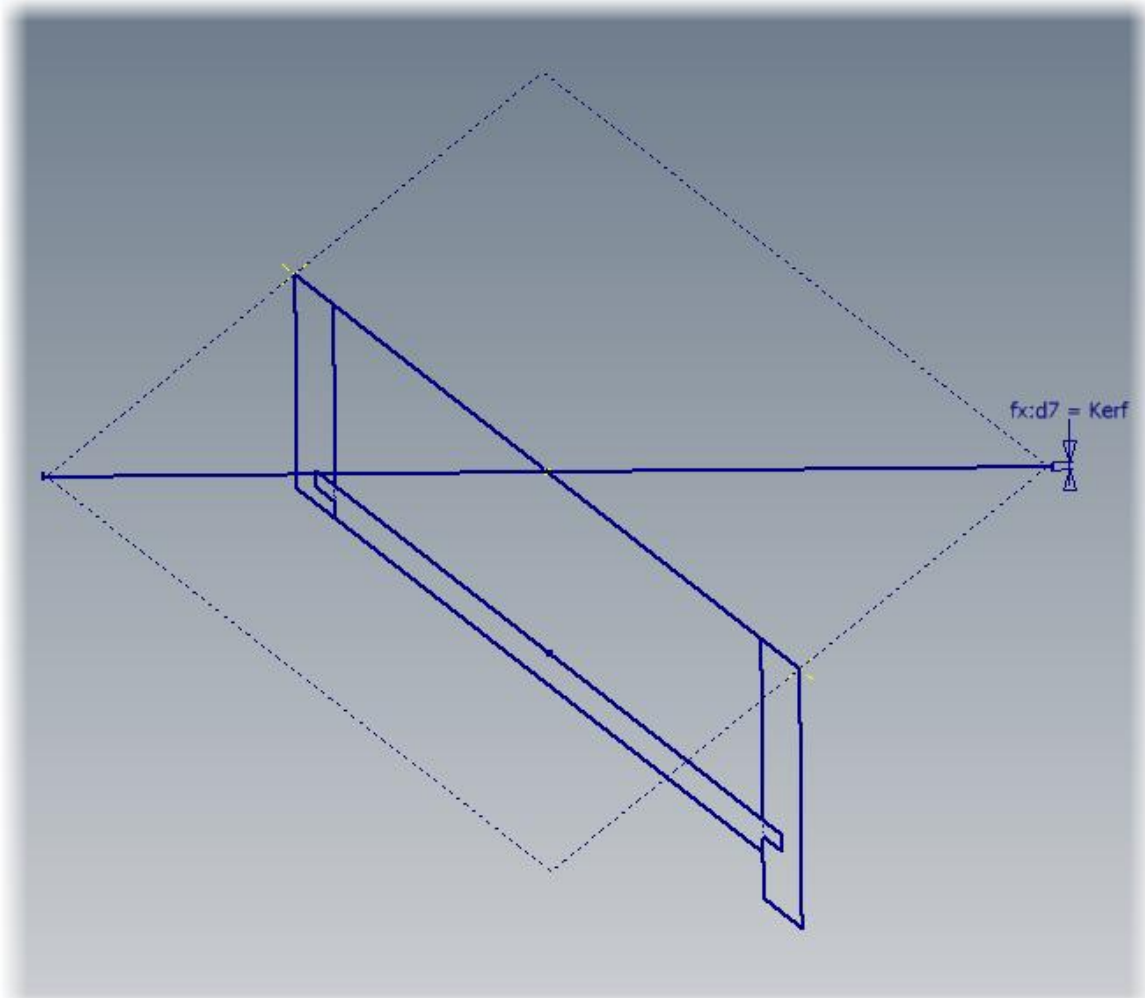




**Modelling a Mitre Block**

Project the corner points through from the Master sketch. Constrain the mid points of the edges of the square to the projected edge points. Use an equal constraint to make both sides the same length.

Toggle back to 'Normal' geometry and draw a line from the point where the projected edge point and the midpoint of the edge line meet, to the same point on the opposite side (i.e. the centreline through the square). Now draw a diagonal line, which extends slightly beyond the corners of the square.



Notice how the ends of the line are constrained with a 'T' to ensure that the diagonal line always extends beyond the perimeter of the square by the Kerf thickness.

## Modelling a Mitre Block

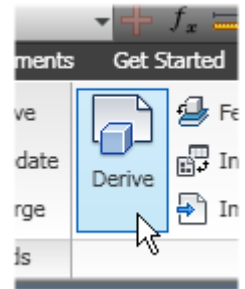
**Deriving the Master Sketch**

We are done creating our 'Master' geometry, so save the 'Mitre Box Master Part' and open a new Part File.

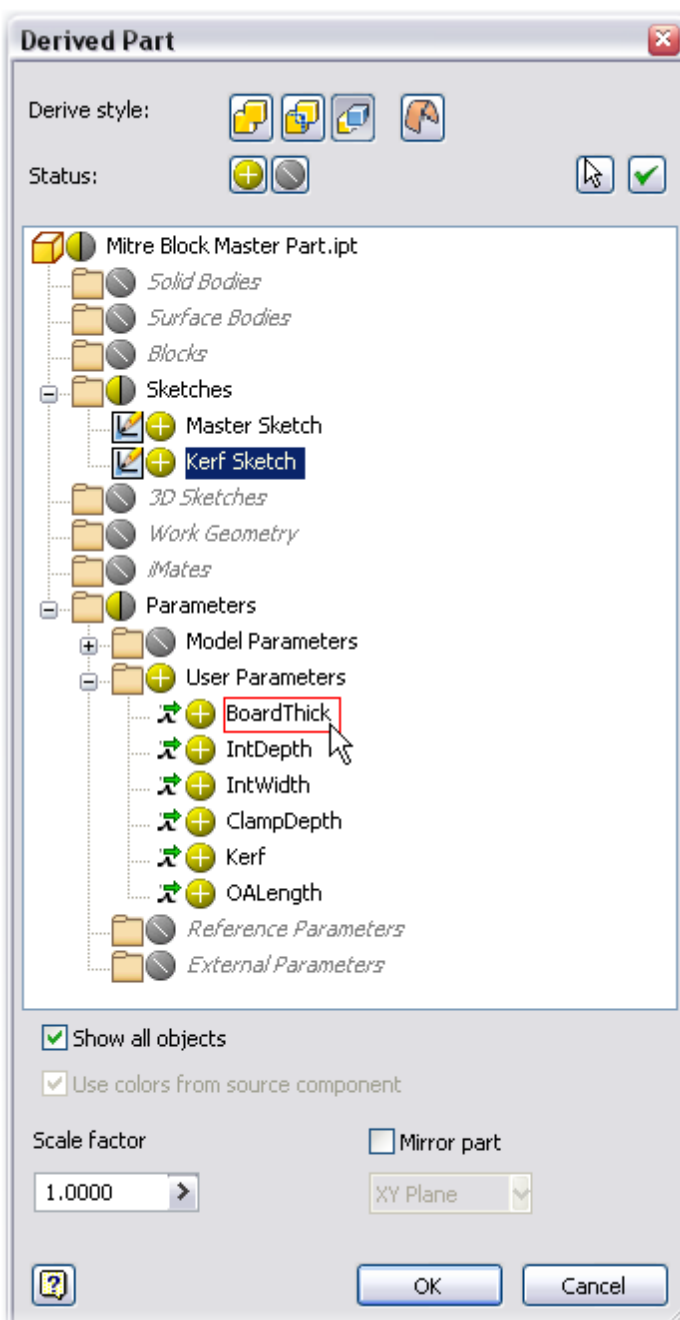
As always, the default sketch will be active. Hit the Big green Tick to return to the part environment. You won't see the derive button inside the sketch environment.

Now Hit the 'Derive' Button

Manage Tab> Insert Panel> Derive



You will be presented with the 'Open' Dialog. Browse to the 'Mitre Box Master Part' we created earlier.



The 'Derived Part' Dialog will pop up. Notice that you can use the tree browser to select Solid Bodies, Surface Bodies, Blocks, Sketches and so on. In fact, anything that is *currently visible* inside the Master Part.

If you want to derive a sketch that has been consumed by a feature inside the master part file, make sure that the sketched is *shared* (just right click on the sketch and pick share from the pop up menu).

I hope that you can see how naming our sketches makes this process much easier.

For this project make sure that the Master Sketch, the Kerf sketch and all our User parameters have been selected.

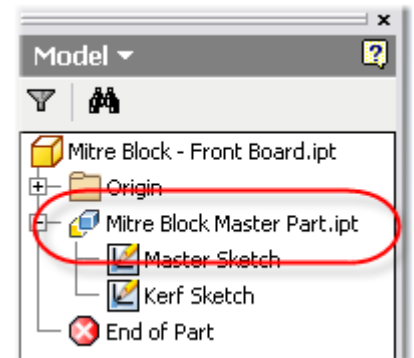
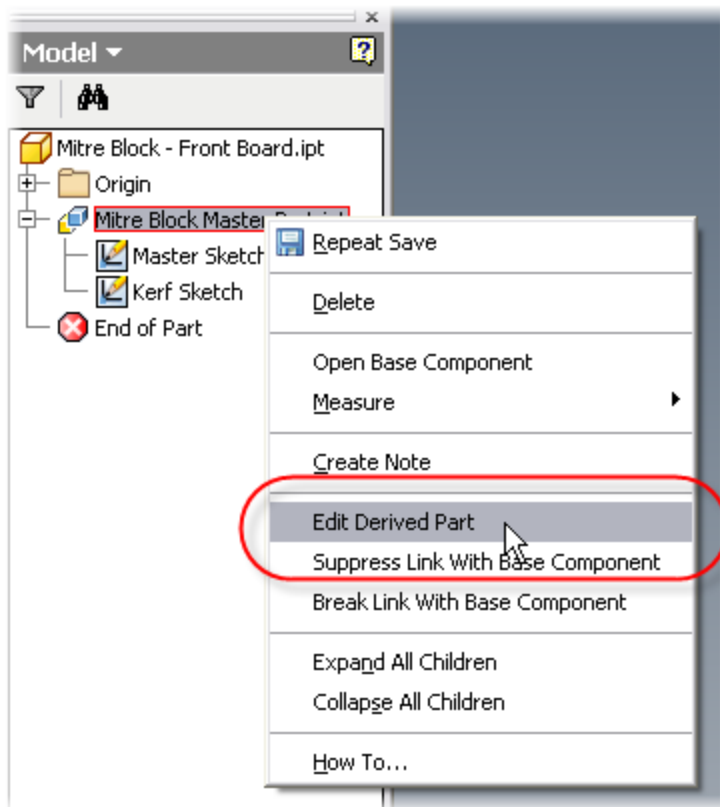
The remainder of the process is very similar to the standard way of creating part model files with Inventor. Create your features using the Derived parameters and sketches inside your part file.



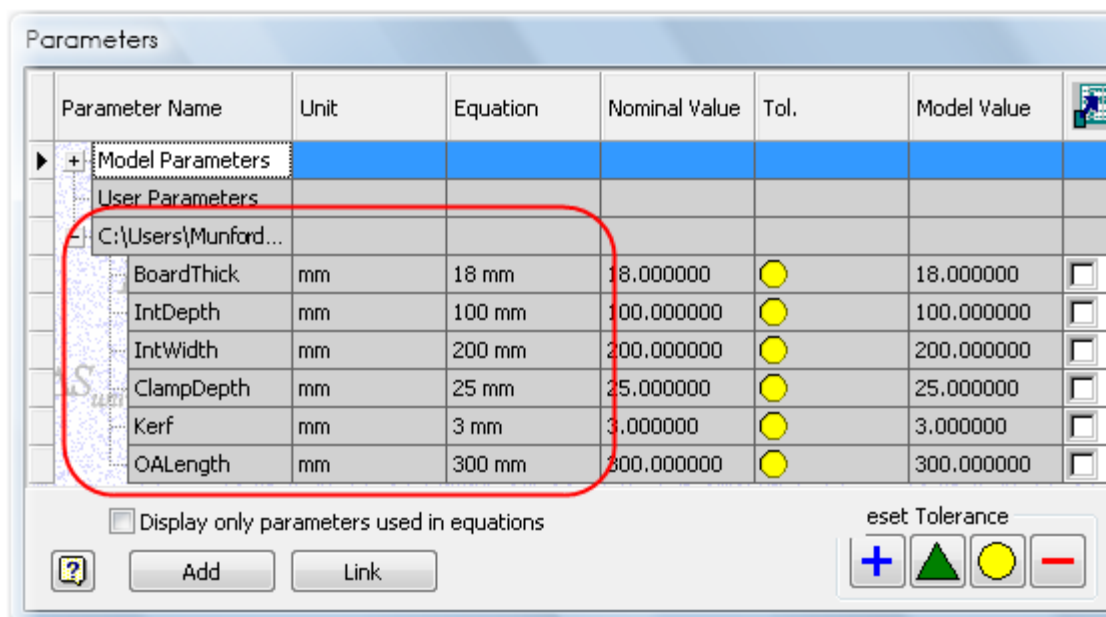
**Modelling a Mitre Block**

Note the new icon in your feature browser. This icon indicates a derived part.

You can edit what has been derived at any time by selecting the derived part node in your browser and right clicking. This will open the derived part dialog again and allow you to revise your selection.



Note that the Parameters we have derived are shown as 'Linked' Parameters in the Parameters manager.



### **Creating a Solid, or 'Sketch based feature'**

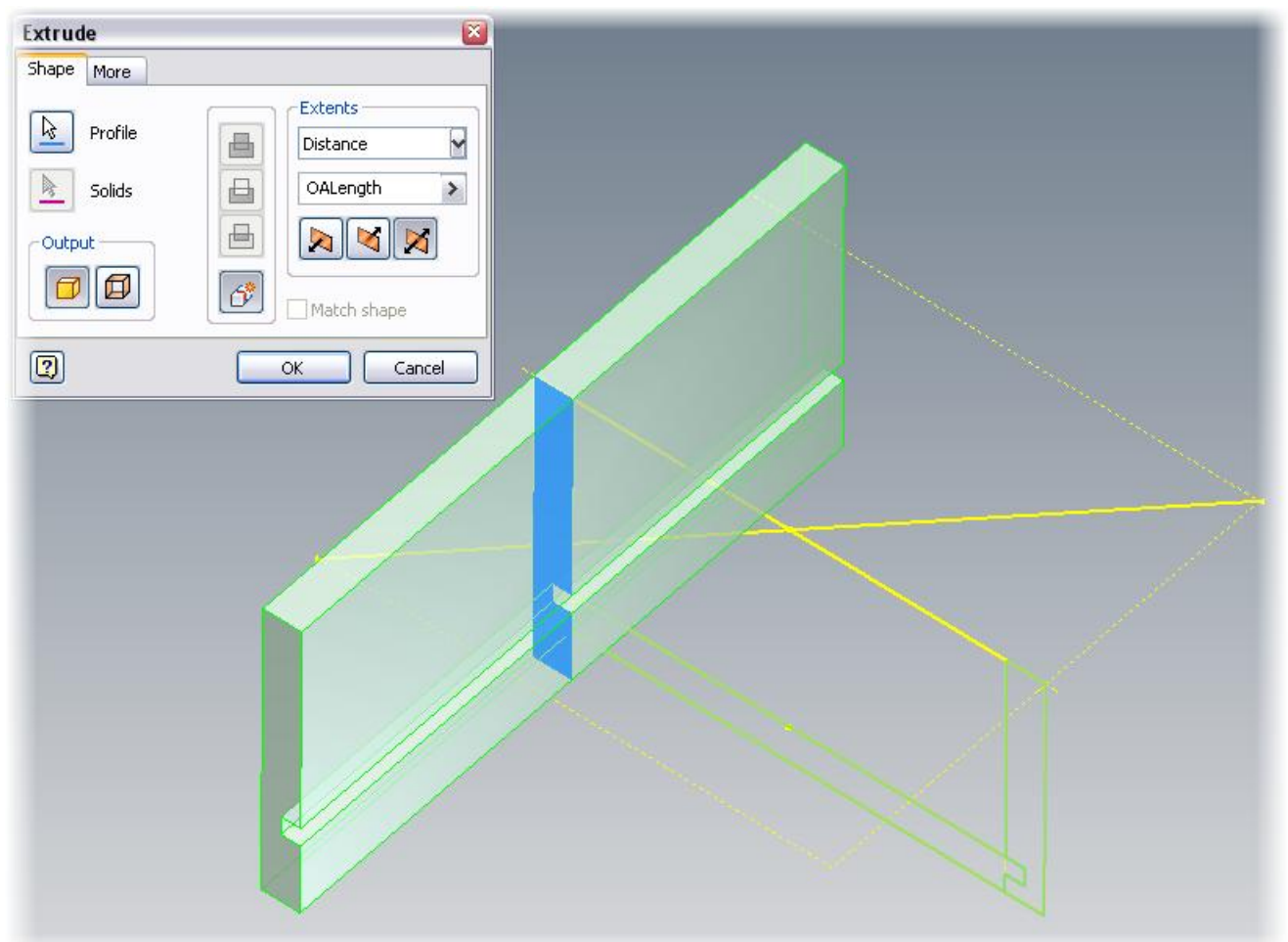
Use the 'Extrude' tool to give your sketch a thickness.

Model Tab > Create panel > Extrude Tool



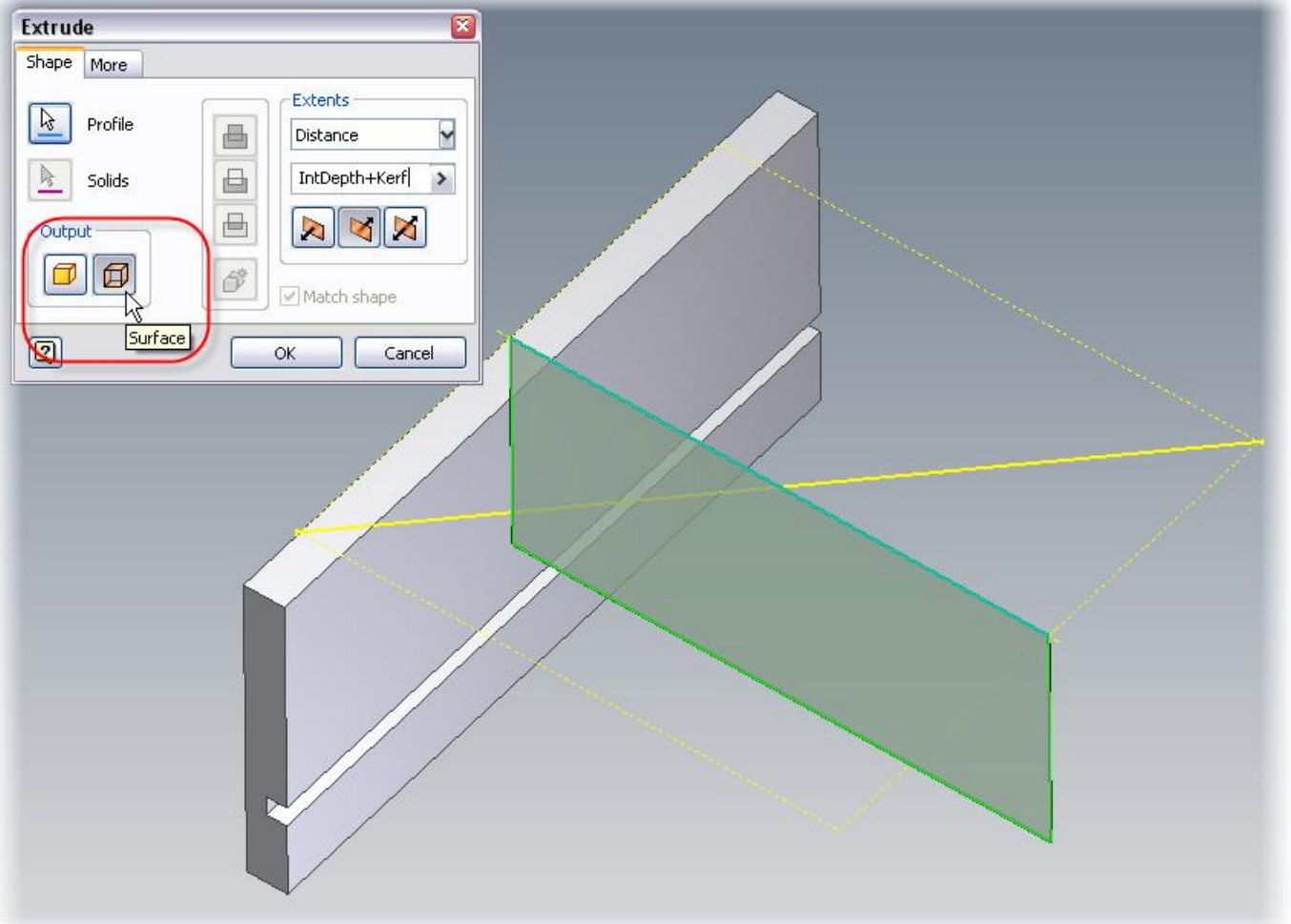
Once again use the fly out arrow at the side of the edit box to pick a parameter from your list of parameters. Or you could type 'OALength' into the edit box directly.

*Note that 'OALength' is one of our derived parameters. If you don't see it in the parameter list, go back and check that you derived it through correctly.*



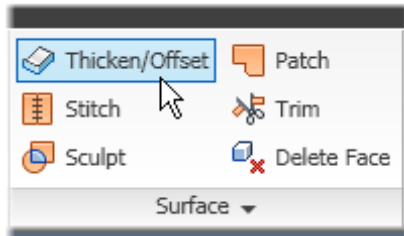
### Creating the mitre cuts

We're going to use the Extrude tool again to create the Mitre cuts. This time, when you start the Extrude tool, click the toggle to create a surface, rather than a solid. Pick the centre line of the Rectangle in our 'Kerf Sketch'. Set the extents to 'IntDepth+Kerf'. This will add the Value of 'IntDepth' (100) with the Value of 'Kerf' (3) Creating an extruded surface 103mm deep.

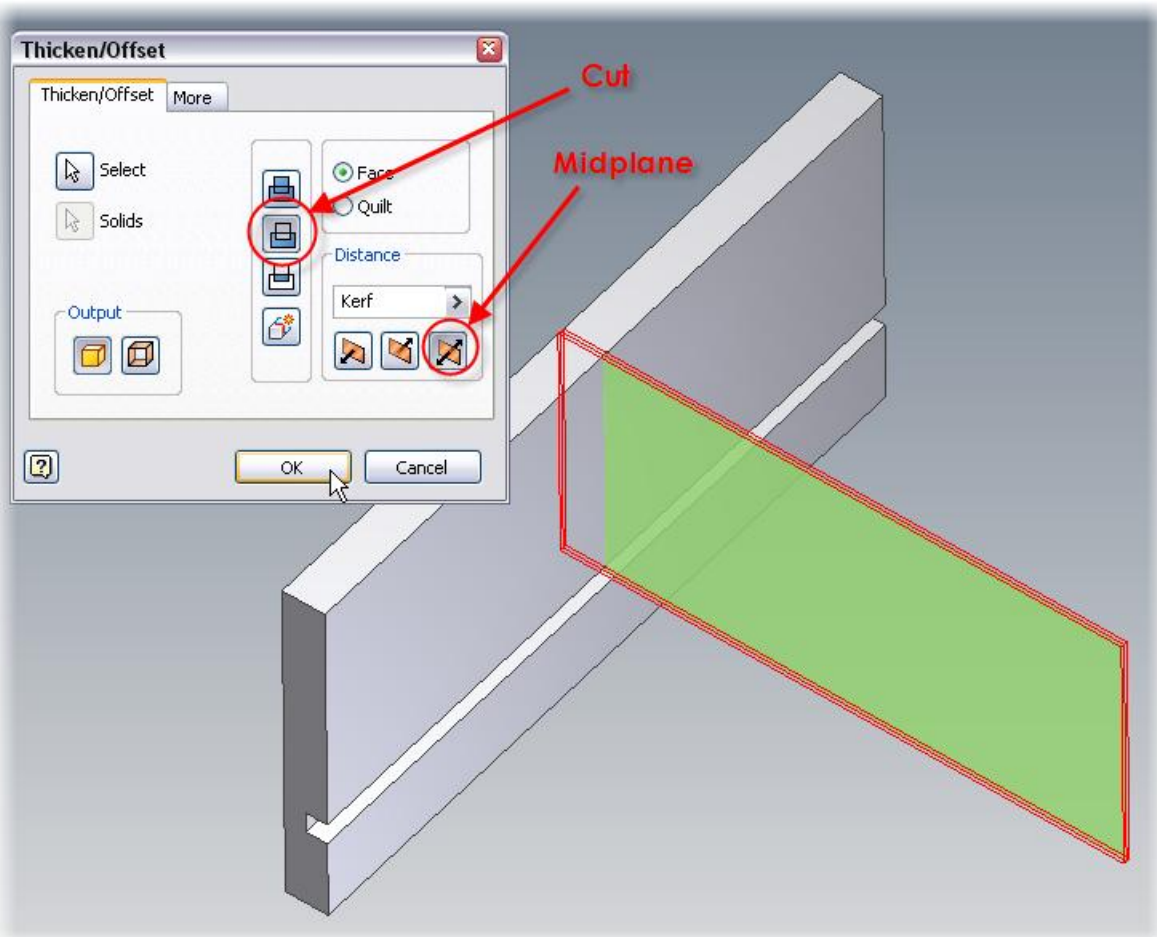


Next, we're going to use the 'Thicken' tool to turn our surface into a cut.

Model Panel > Surface Tab > Thicken/Offset



Chose the 'Cut' and 'MidPlane' options in the Thicken/Offset dialog. Set the distance value to 'Kerf'.



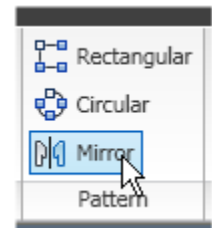
Repeat the process for the diagonal line in the kerf sketch.

**Modelling a Mitre Block**

Finally we will Mirror the diagonal cut feature using the original extruded surface as a centreline.

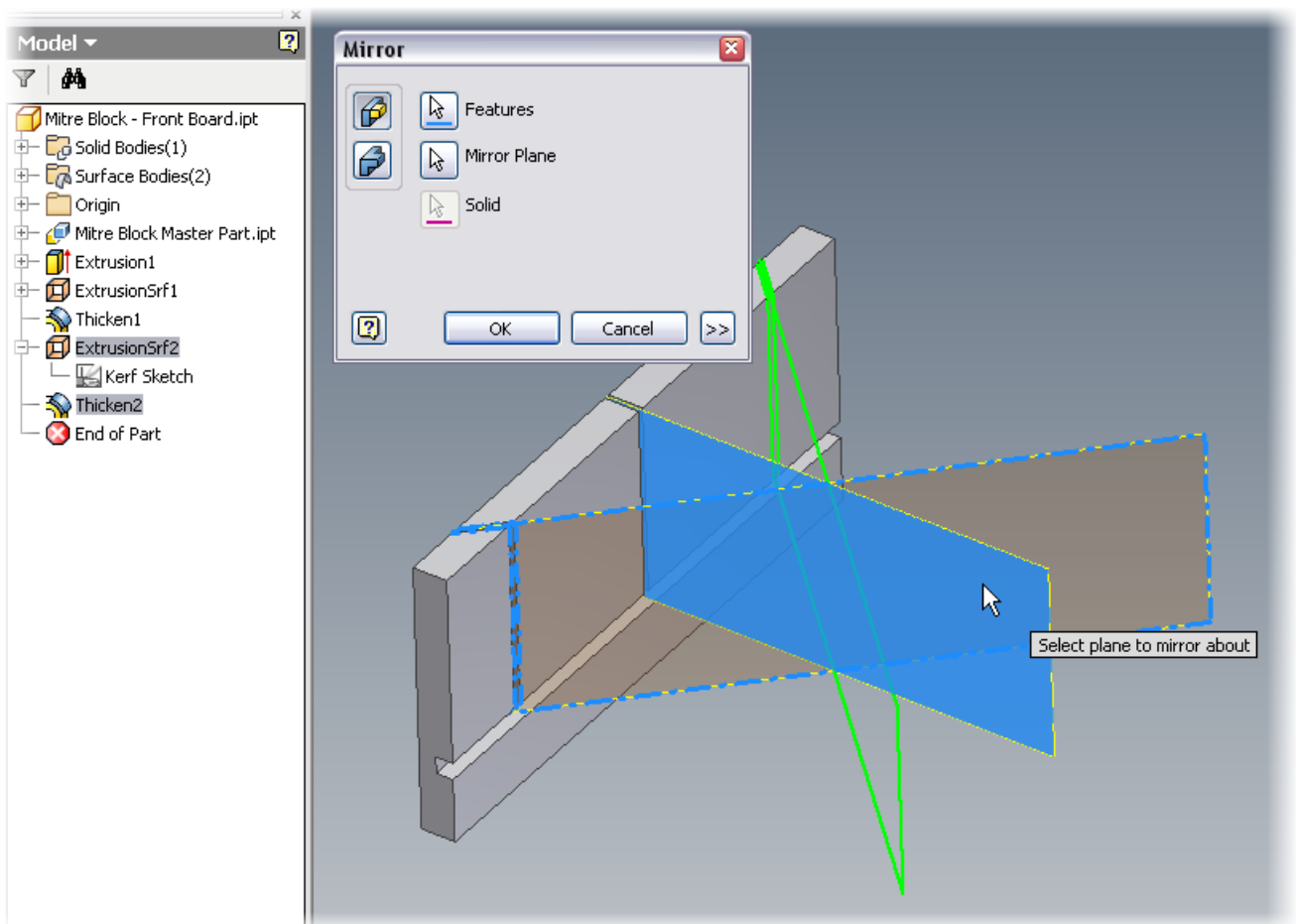
Check that 'ExtrusionSrf1' is visible before starting the mirror command.

Model Tab > Pattern Panel > Mirror



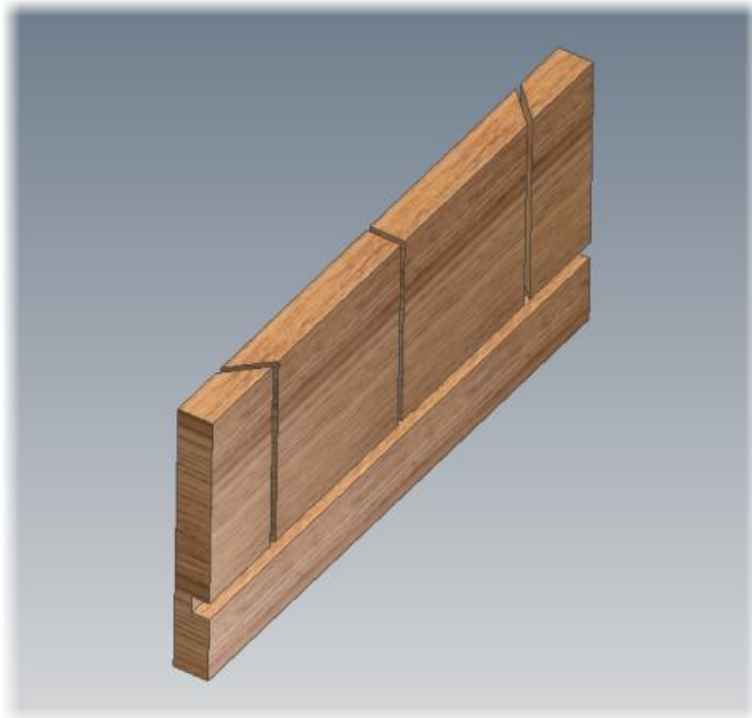
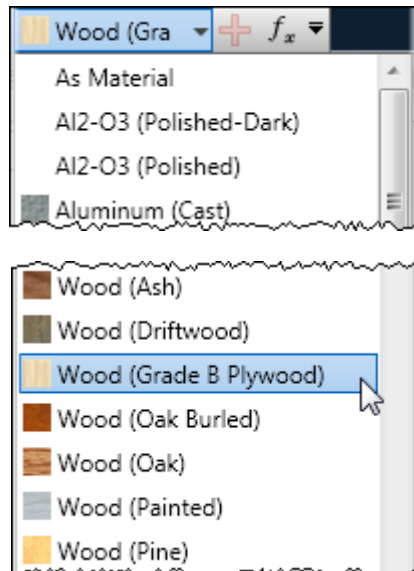
Use the 'Features' Button to pick both 'ExtrusionSrf2' surface and 'Thicken2' in the feature browser.

Use the 'Mirror Plane' button to pick 'ExtrusionSrf1' from the graphics window.



### Changing the look of the part

You can use the Colour override drop down to allocate a different look to your part.



When you are happy with your part, save your part as 'Mitre Block – Front Board'. You have successfully created your first derived part. That was easy!

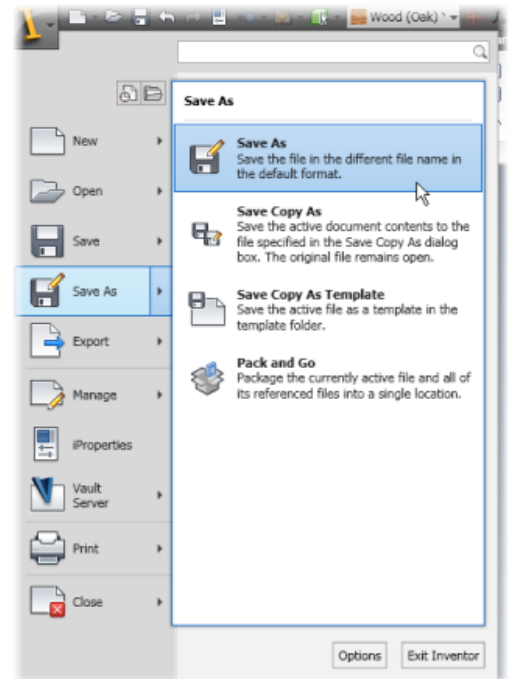
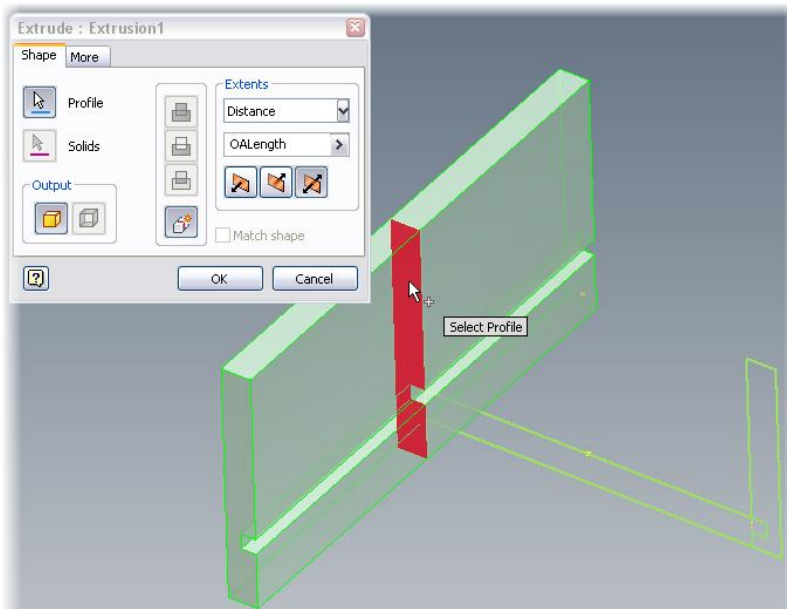


**Modelling a Mitre Block****Creating the remaining parts**

You don't have to go through this entire process again to create the remaining parts. Use the 'Save As' command to create a copy of 'Mitre Block – Front Board'. Name this file 'Mitre Block – Base Board'.

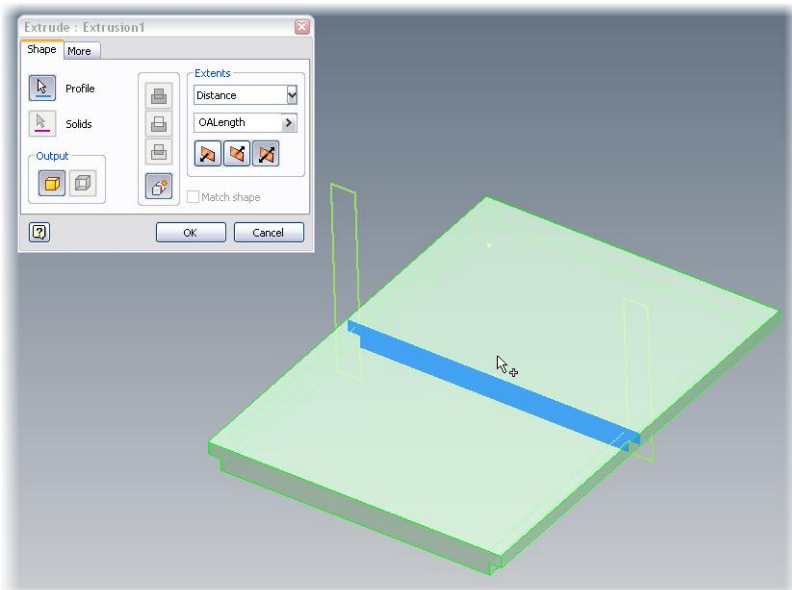
Big I > Save As > Save As

Now double click on the 'Extrusion1' feature in the feature browser. This will allow you to edit the extrusion feature. Click on the 'Profile' Button, then hold down the CTRL Key and pick the 'Loop' that we extruded earlier. This will deselect this loop. Note that it is coloured red to show that the loop is being taken away from the selection.



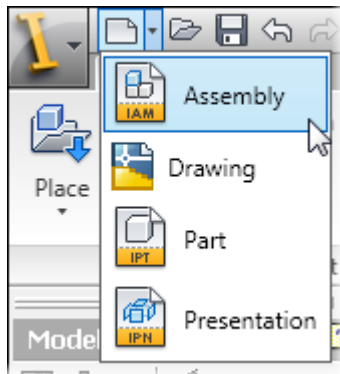
Now lift your finger off the CTRL key and pick the next loop. Notice that the loop is now blue to show that it has been added to the selection.

Save the part and repeat the process to create the 'Mitre Box – Back Board' Part.



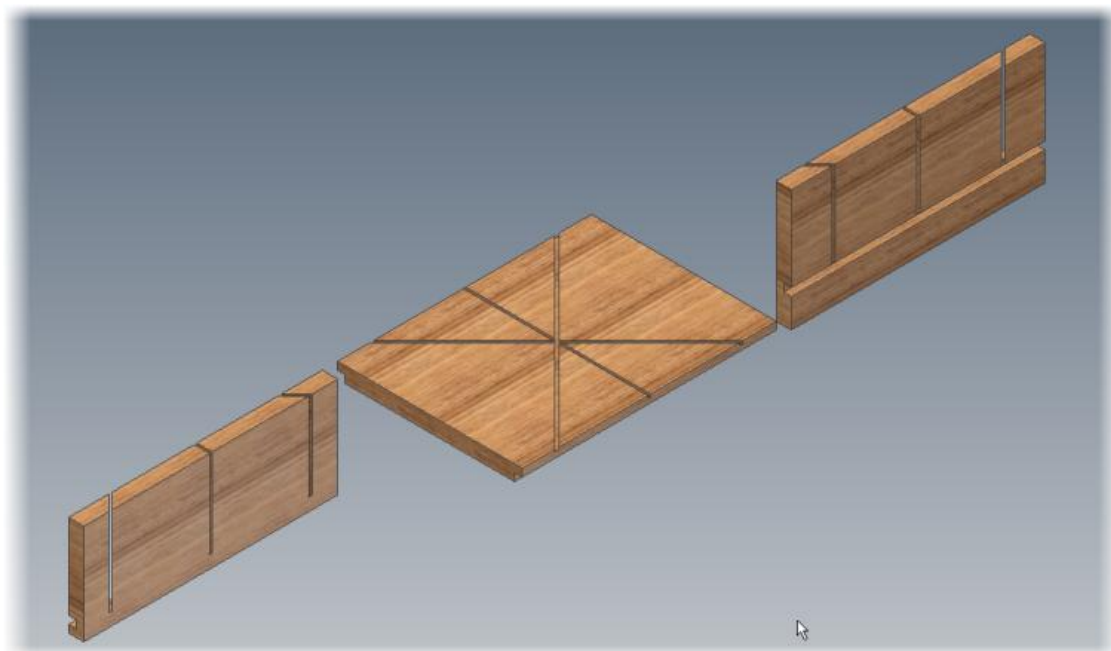
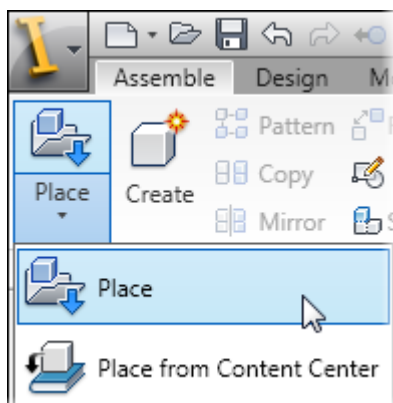
## Creating the Assembly

Open a new assembly File



Use the 'Place' tool to insert our parts

Assemble Tab > Component Panel > Place Tool



## Modelling a Mitre Block

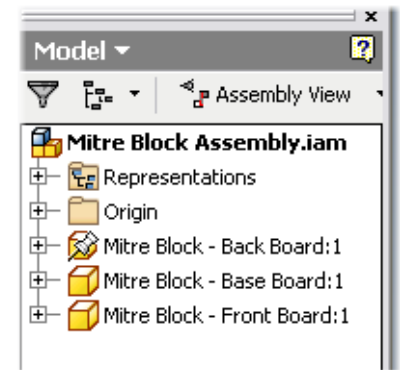
**Assembly constraints**

You may notice that the first part that you insert in any assembly will automatically be 'Grounded' – This is indicated by the Push Pin Icon on the part node in the browser.



Every part that you insert into an assembly has Six degrees of freedom. Forwards and Backwards – Left and Right – Up and Down, and your part can rotate about its X, Y, and Z Axis.

You can use Assembly constraints to lock down the position of your parts. Grounding the first part makes it easier to ensure that you have limited the freedom of your parts.



*Using the 'Skeletal' modelling technique we can avoid having to use assembly constraints to control our assembly model. We will place each part using the origin (0,0,0) as the base point. We will then 'Ground' all the parts. The skeletal model – our Master file, controls the size and shape of our parts and the layout of our assembly.*

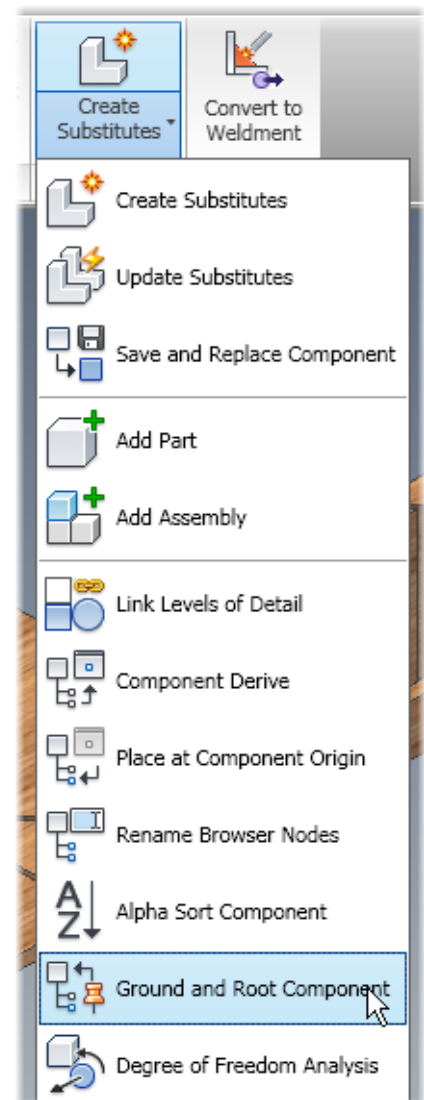
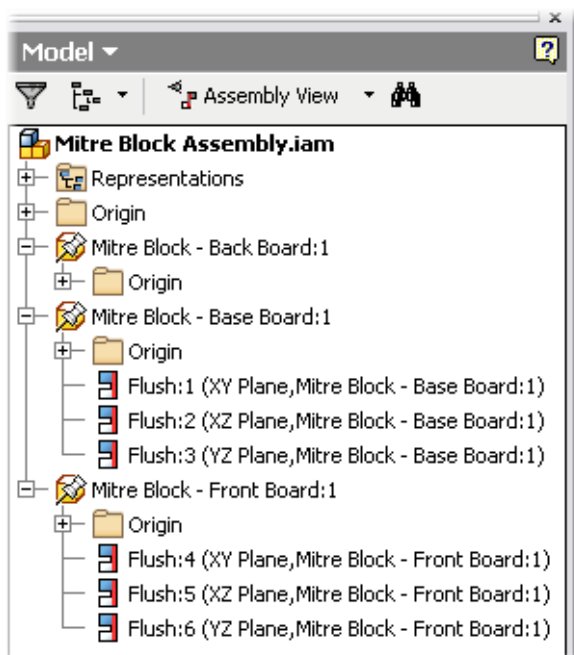
**Ground and Root**

Thankfully, Autodesk have included a tool which will help us move all our parts to the origin and ground them in place.

Assemble Tab > Productivity Panel > Ground and root component

This tool will move each component to 0,0,0, create the necessary constraints between the Part origin planes and the assembly origin planes, and ground the components in place.

Unless you need to add constraints to show mechanical motion, you may never need to bother with assembly constraints again!

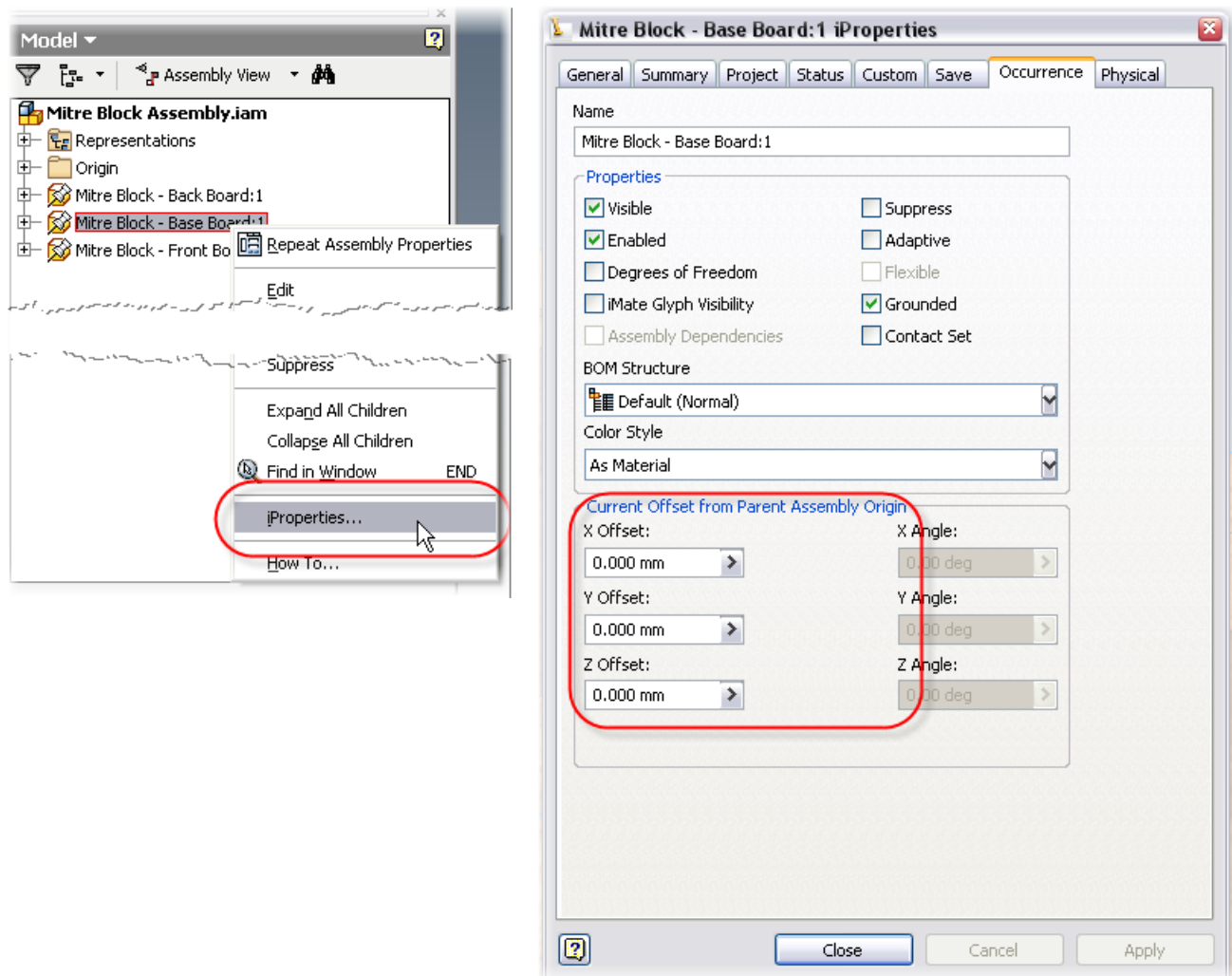


## Modelling a Mitre Block

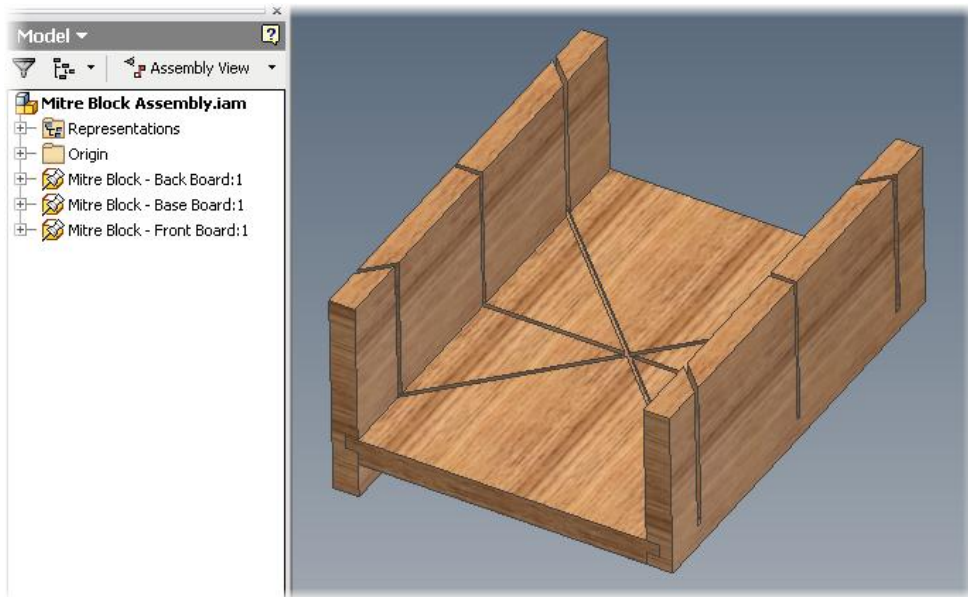
To demonstrate what has happened, right click on any part and choose 'iProperties'.

Choose the 'Occurrence' tab and look for the 'Current offset from parent Assembly Origin' Values.

Note that it is possible to change these values manually (if the part isn't grounded and constrained!).



## Modelling a Mitre Block

**Testing your skeletal model**

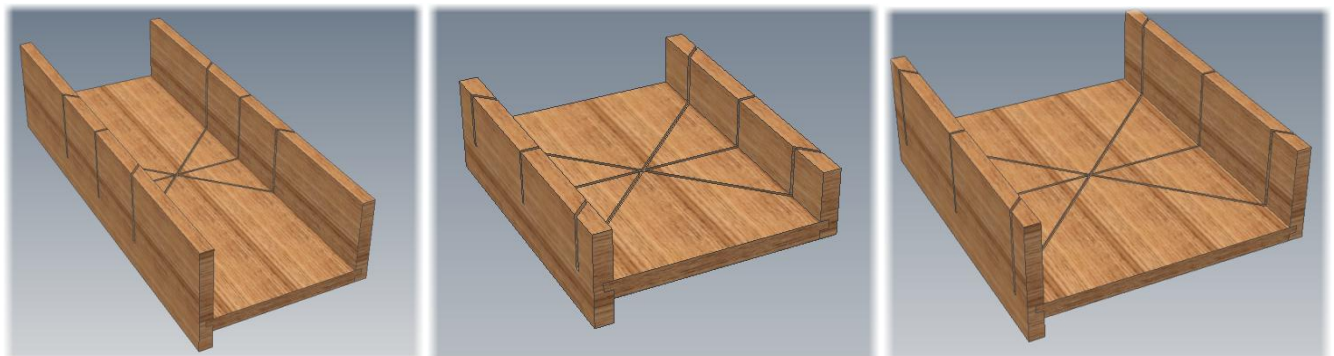
Open your 'Mitre Block – Master Part' for edit. Open the parameters dialog and experiment with changing the 'IntDepth', 'IntWidth' or 'OALength' parameters that we created earlier on. After each change, save your Master file and return to the assembly model. Click on the 'Update' tool to see the parts update (you may need to click twice).



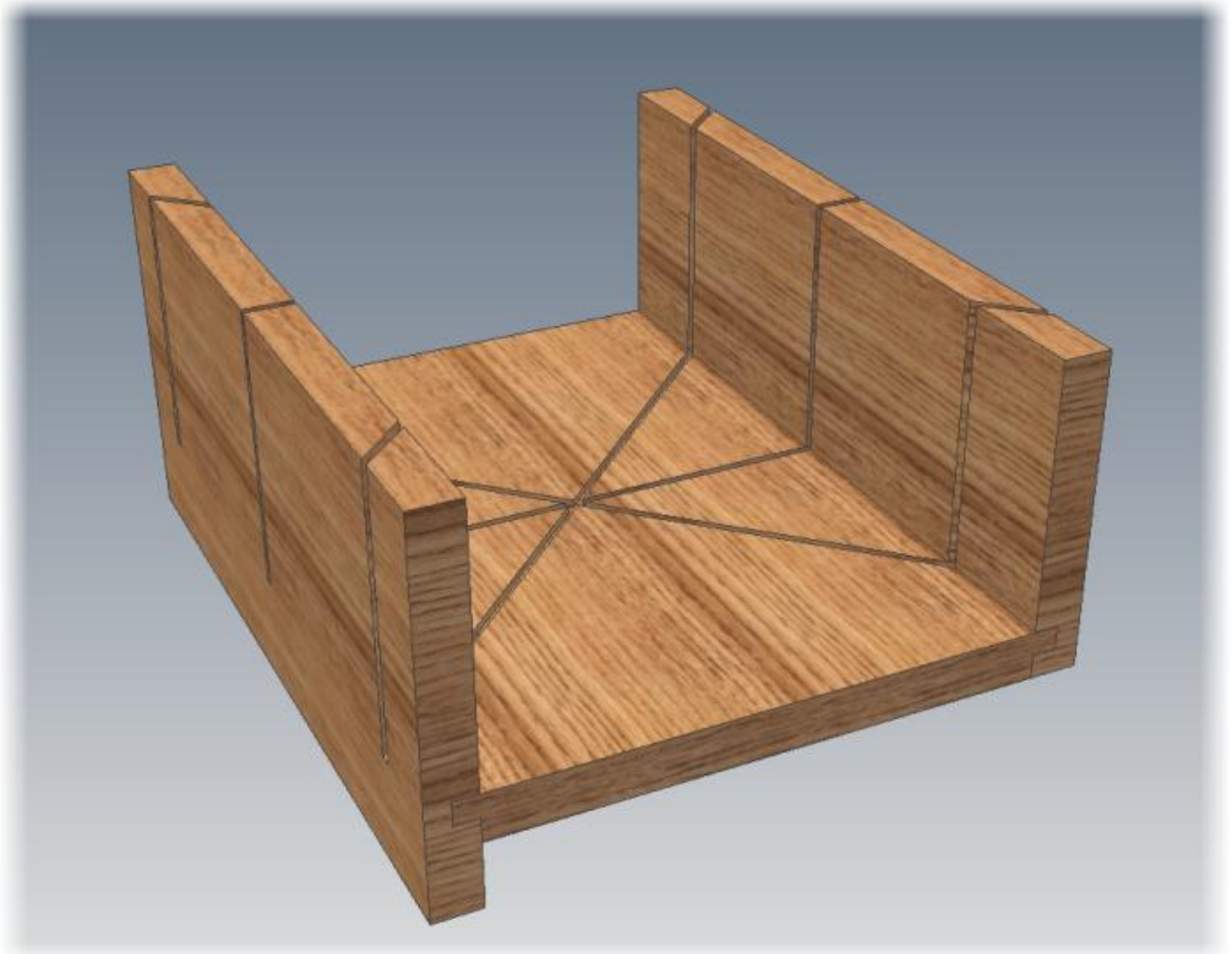
Note that the parts that make up the Mitre Block Assembly are all linked to the Master file. As you make changes to the Master file, the assembly model updates as well. Note that there are no constraints to fail!

*Skeletal modelling is a really cool way of creating mid to large assemblies that automatically update based on the values held within a master part. Note that the Master part file needs to be managed along side the part and assembly files. If you loose your master file the whole assembly may fall down around your ears! Skeletal modelling is probably not appropriate for Library parts. Don't forget that you could use one of your parts as a master part or you could insert your master part into your assembly.*

*Note also that our parts don't contain any value for 'Length', 'Width' and 'Thickness' We would need to manually add these into each part if we wanted them to be included in the Bill of materials (BOM) and parts list. This can be time consuming, so don't be tempted to derive every part when you could re-use a part or use a library part instead.*







That's your Mitre Box model completed! I hope that you are pleased with your results. I hope that you now have an understanding of how to use derived parts to create an assembly model, in which the assembly is controlled by a master part.

This isn't the only technique for producing assembly models in Inventor. We could also have used the 'Bottom up', 'Top Down' or 'in place' techniques', but that's next week...

**Key Concepts:**

1. Create a master part
2. Add parameters
3. Add work features
4. Add sketches
5. Geometrically constrain sketches
6. Dimension sketches
7. Create a new part
8. Derive the master part into the new part
9. Add features
10. Place the parts into an assembly
11. Ground and root